SOLAR WIND LATITUDE VARIATIONS

Analysis of the Mariner 10 Lyman-alpha data has made possible the first determination of variations in the solar wind flux out of the ecliptic. Previously, velocity measures have been made of the "solar wind" in the out-of-the-ecliptic region by ground-based observations of interplanetary scintillations from high latitude radio sources and by studies of comet tail orientations from high latitude comets. But the new JPL analysis has produced the first flux measurements at high latitude.

The new study is considered important in the planning of the forthcoming International Solar Polar Mission that is designed to ascertain in detail the solar wind properties out of the ecliptic. This information will be added to the well-known solar wind ecliptic properties as measured by planetary probes.

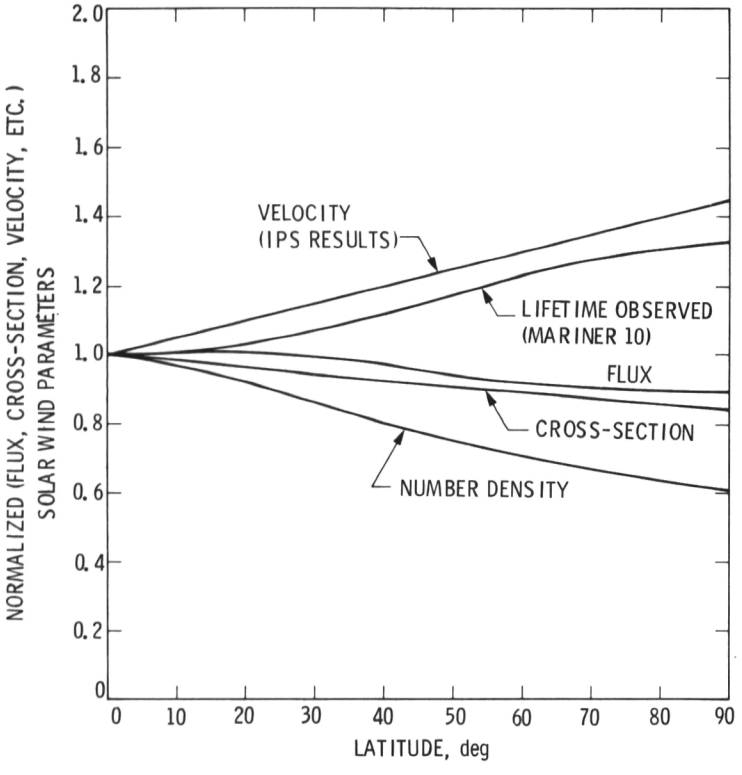
As it approaches the sun, the interstellar neutral hydrogen flowing into the solar system, known as the "interstellar wind," is ionized, largely from charge exchange reactions with solar wind protons. The reactions decrease the amount of Lyman-alpha radiation from the neutral hydrogen, excited by Lyman-alpha radiation from the sun.

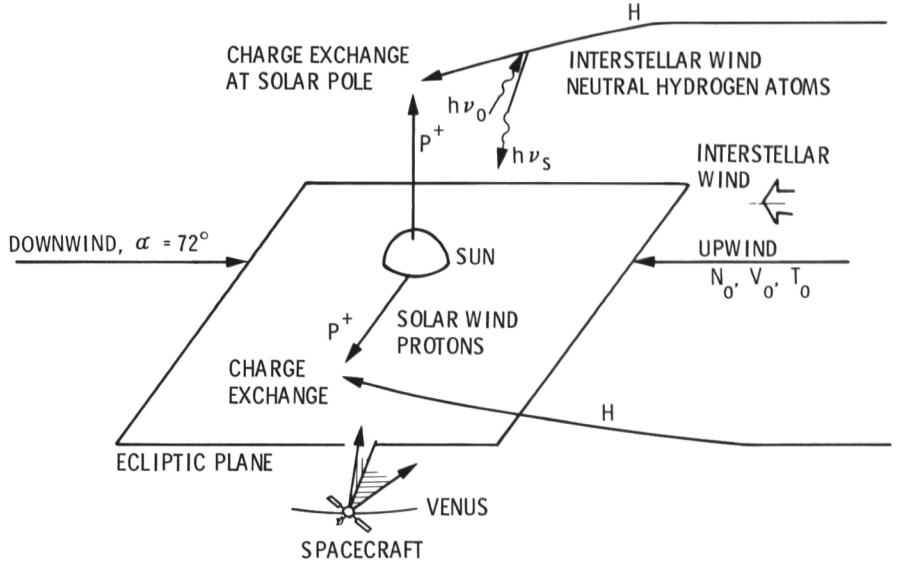
The Mariner 10 Lyman-alpha measurements show an enhancement of the backscattered radiation from those lines of sight nearest the solar poles. From this it can be deduced that at higher solar latitudes the loss of neutral hydrogen from ionization by solar wind protons is less than at lower latitudes.

The Lyman-alpha data made it possible to determine quantitatively the latitudinal dependence of the charge exchange rate of solar wind protons with neutral hydrogen. It was found that the mean charge exchange rate decreases with latitude by 33 percent between the solar equator and the poles. This corresponds to an increase of the neutral hydrogen ionization lifetime of 25 percent.

The latitude variation of hydrogen lifetime can be coupled with the interplanetary scintillation measurements (which show that the solar wind speed increases with latitude) to determine the average solar wind mass flux variation and density variation as a function of latitude. The results imply that the solar wind flux decreases at the solar pole to about 85 percent of its equatorial value.

The study emphasizes the importance of the out-of-the-ecliptic mission to measure the effects of the solar cycle on the high latitude flux and on other important solar wind parameters such as magnetic field strength and solar activity center locations. The latter parameter is important in determining whether a polar variation of solar wind fields is induced by high latitude solar activity centers.





The graph (left) shows the results of the Mariner 10 interplanetary Lyman-alpha observations of latitude variations in the solar wind. The drawing outlines the geometry for the interplanetary Lyman-alpha observations and indicates how protons from the sun interact with neutral hydrogen from the interstellar wind.